

EPA Coalbed Methane Outreach Program Technical Options Series

## ***USE OF COAL MINE METHANE IN IC ENGINES AT COAL MINES***



225 kW Synchronous Skid-Mounted Generator at Nelms No. 1 Mine, Ohio  
(Photo courtesy Northwest Fuel Development, Inc. and U.S. DOE)

### ***A PRACTICAL APPROACH TO POWER GENERATION AT COAL MINES...***

- ◆ Economic benefits to coal mines, power producers and end users
- ◆ Improved on-site power supply reliability
- ◆ Modular design accommodates fluctuations in gas supply
- ◆ Commercially proven at the Nelms No. 1 Mine, Ohio, USA and at the Appin and Tower Collieries, New South Wales, Australia
- ◆ Reduces emissions of coal mine methane, a greenhouse gas

IC engines operate on gas at atmospheric pressure; they do not require compressed fuels like gas turbines

Maintenance and parts for IC engines are readily available

IC engines operate on gas at atmospheric pressure; they do not require compressed gas like gas turbines

## ***Why Consider Using Coal Mine Methane in IC Engines?***

**M**ining of underground coal deposits releases large quantities of methane gas, which presents a safety hazard to miners and therefore must be ventilated or removed. Mines can drain methane ahead of mining operations through the drilling of vertical wells in the surrounding coal seam. Vertical wells usually produce high quality gas, (over 90% methane concentration) with a heating value of over 900 Btu/cf. In contrast, gob wells (drilled into collapsed rock over mined-out areas) produce medium quality gas that generally contains 30-80% methane.

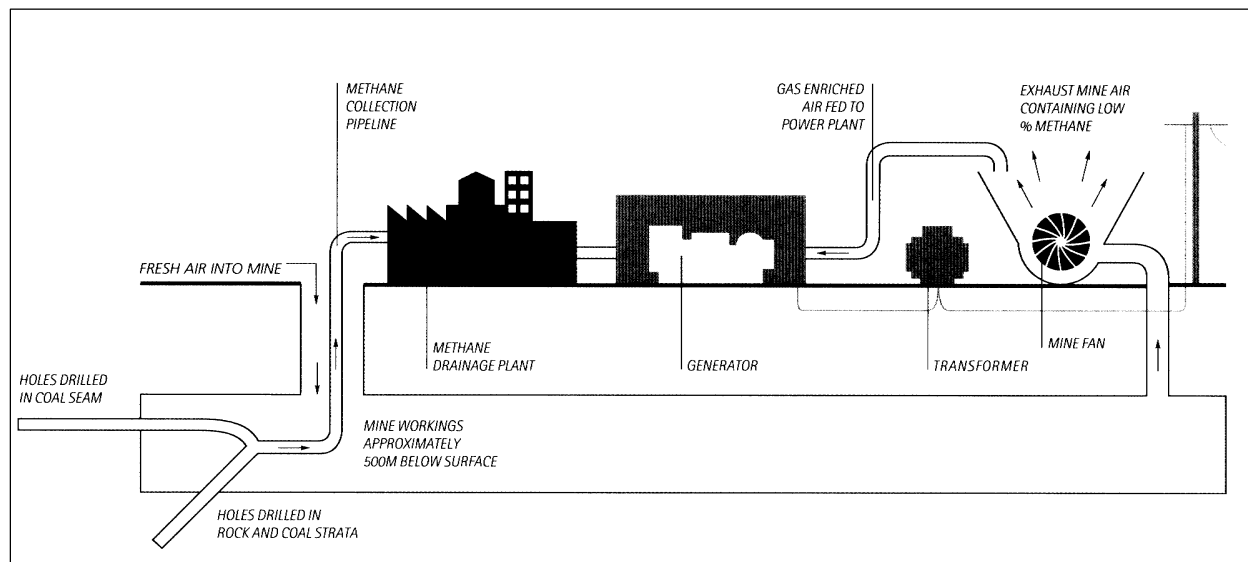
Most methane recovery operations inject pipeline quality gas directly into a pipeline and sell it to utility companies. Mines often vent the medium quality gas they drain from gob wells into the atmosphere instead of using it, because gob gas requires enrichment prior to pipeline injection. However, fuel for power generators does not require pipeline quality gas. Generally, IC engines can be adapted to generate electricity using coal mine gas with a methane concentration as low as 20%. (For safety reasons, however, mines usually cease production of gob gas if the methane concentration drops below 25%).

In Ohio, Northwest Fuel Development, Inc. (NW Fuel), with the assistance of the U.S. DOE, has developed power generators that use medium quality gas. The "prime mover" in NW Fuel's power generating set is a 100 hp IC engine manufactured by General Motors. Properly configured carburetors in this light truck engine allow for the use of fuels ranging from 20% to 100% methane. The engines generally provide service for over 12,000 hours (or one and one-half years) before any significant maintenance is required. After maintenance, the engines are placed back in service for another 8,000 to 10,000 hours before they are replaced.

NW Fuel recovers methane from the Nelms Mine No. 1 and generates power for on-site use at the neighboring Nelms Cadiz Portal Mine. Through the use of common mass-produced GM engines, the power-generating equipment developed at the Nelms Mines produces low-cost electricity by keeping capital and operating costs to a minimum. Currently, the project also sells some electricity directly to American Electric Power Company, a local utility.

### ***SOME FACTS ABOUT POWER GENERATION AT THE NELMS COAL MINES...***

- Current nine-unit system capable of generating 675 kW of electricity
- System uses about 225,000 cubic feet of coal mine methane per day
- Existing units produce three-phase electricity at 480 volts
- Installed costs of generator sets and utility-required protective relays are less than \$800/kW
- Produce power for less than \$0.025/kW-hr



Use of methane at the Appin Colliery for power generation in IC engines  
(Schematic courtesy of Energy Developments, Ltd.)

On a larger scale, Energy Developments Ltd. (EDL) has developed a power project in Australia that uses coal mine methane (supplied by BHP's Appin and Tower Collieries) to generate electricity for the local utility grid. The project cuts the mines' methane emissions in half and delivers a total of 94 MW of power to the utility grid during peak demand hours. Of this, 4-10 MW is fed back from the utility grid to meet the mines' equipment energy requirements, such as ventilation fans, power equipment, and other critical loads. The remaining power is supplied to Integral Energy Australia. By purchasing power from this project, Integral Energy, a local distribution company and energy trader, expects to save its customers more than \$US 2.4 million annually. To ensure consistent gas quality and quantity, EDL uses an electronic monitoring and control system to supplement the coal mine gas with natural gas when necessary.

As with the Nelms Mines, this innovative project converts coal mine methane to electricity using a conventional internal combustion engine. In this case, a 16-cylinder Caterpillar G3516 bulldozer engine is connected to a Cat SR4 brushless generator. Housed in soundproof sheds, the 94 generator sets convert over 20 million cu ft/day of coal mine methane to 94 MW of electricity. Each generator set is expected to operate up to 8000 hours a year. A gas turbine-based system was not considered as cost-effective because of the need to compress the gas before fueling, and because experience had shown that maintenance could be a problem at the site.

### ***SOME FACTS ABOUT THE USE OF IC ENGINES AT THE APPIN POWER PROJECT...***

- Each engine directly drives one 415 volt 1 megawatt generator
- Fuel gas composition varies from 50 - 85% methane, 0-5% CO<sub>2</sub>, and up to 50% air
- Modular design provides for off-site fabrication, ease of relocation, and staged expansion
- Mine ventilation air from Appin Colliery, containing 0.5 -1.0% methane, supplies all of the combustion air to the 54 units at the Appin plant (mine design prohibits this option at Tower)

## ***For More Information...***

The economic success at the Nelms Mines in Ohio and the Appin and Tower Collieries in Australia is prompting coal and electricity producers worldwide to take a new look at using methane-fueled internal combustion engines for power generation. This approach has the added benefit of reducing methane emissions by converting a waste product into electricity.

To obtain more information about using coalbed methane in gas engines, contact:

Mr. William Lazarus  
General Manager  
Energy Developments, Ltd.  
P.O. Box 535  
Richlands, QLD  
Australia  
Tel: (61) (7) 3275 5555  
Fax: (61) (7) 3217 0733

Dr. Peet Sööt  
Northwest Fuel Development, Inc.  
4064 Orchard Drive  
Lake Oswego, OR 97035  
Tel: (503) 699-9836  
Fax: (503) 699-9847

**Or contact the EPA's Coalbed Methane Outreach Program for information about this and other profitable uses for coal mine methane:**

Coalbed Methane Outreach Program  
U.S. EPA  
401 M Street, SW (6202J)  
Washington, DC 20460 USA  
Tel: (202) 564-9468 or (202) 564-9481  
Fax: (202) 565-2077  
e-mail: fernandez.roger@epa.gov  
schultz.karl@epa.gov

<http://www.epa.gov/coalbed>



The mention of products or services in this case study does not constitute an endorsement by EPA